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ABSTRACT

The purpose of this investigation was to evaluate the effects of presenting a well structured time-telling program to children at the K-3 level. Twenty classes in two schools (two experimental and three control groups for each grade) participated in the study. Experimental group teachers were selected on three effectiveness criteria, and pretest, posttest, and retention test measures were therefore analyzed using descriptive statistics. The instruction, which lasted ten days and had as its terminal objective telling time to the nearest minute, was found to produce "educationally significant" differences only at the grade one level. No anxiety increases were detected as a result of using the program. In an appended paper, "Curriculum Decision: Learning Time Concepts and Skills," the author relates this instructional achievement to Piaget's car velocity experiments. Curriculum implications are discussed. (The paper is based on the author's doctoral dissertation.) (MM)

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Abstract

The purpose of this investigation was to evaluate the effects of presenting a well-structured time-telling program to children at the kindergarten level, grade one, grade two and grade three. The terminal behavioral objective was to be able to tell time correctly to the precision of a minute. This elementary school mathematics topic is traditionally taught at the end of second grade and most usually third grade.

Factors controlled for comprise three categories: (a) the children were pretested to insure that all had the cognitive readiness to start the instructional program: (b) the Experimental Group teachers were selected on a criterion basis to insure that none were first year teachers, that none were known to be poor math teachers, and that no teachers selected were unlikely to follow the lesson plan procedures; and (c) the situational controls provided a Comparison Group at each of the grade levels, maintained a natural teaching environment by having the classroom teachers do the teaching, and provided observations on possible increases in anxiety in teachers and in students during the experimental period.

Three effects of the accelerated program were evaluated:

1. At which grade levels did 80 percent of the Groups attain 80 percent of the test items correct?

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2. At which grade levels did the greatest number of children seem to benefit from the accelerated program?

3. At which grade levels was the "learning retained after six weeks of no classroom time-telling instruction?

Descriptive statistics were used, and differences between accuracy mean scores and between percentages of children learning the task were judged on the concept of "educational significance".

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AN EVALUATIVE STUDY OF THE EFFECTS OF COGNITIVE ACCELERATION[1] IN MATHEMATICS IN THE EARLY SCHOOL YEARS

Fredricka K. Reisman

The purpose of this investigation was to determine at how early an age children can learn to identify time to the precision of a minute, and if they were able to retain this skill after a retention period of six weeks of no instruction.

Telling time to the minute (6:37) is usually not taught until third grade when most children are about eight years old. Seven year olds (second grade) learn time to multiples of five minutes after the hour (6:35) preceded by learning time to the quarter hour (6:15). Identifying time on the hour (6:00) and the half-hour (6:30) are taught anywhere from preschool (four year olds) to first grade (six year olds).

This traditional sequence of teaching time to the minute as the last step in the sequence was modified by the investigator. An analysis of the task[2] revealed that once the children could identify time on the hour, a more natural next step was to count the minutes. Consider time on the hour as equivalent to zero minutes after the hour, then one minute after the hour, then two minutes after the hour, etc. This appeared logical since children learn to count by ones first rather than by 15's or by 30's or by 5's. Thus, both the mathematical aspects of

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the task and the psychological regard for how children first learn to count provided the rationale for this teaching sequence.

Design of the Study

The evaluative research design used as the model for this study was described as Quasi-experimental Design 10: The Non-equivalent Control Group Design, by Campbell and Stanley (1963, pp. 217-220), and as Pre-test, Post-test, Control Group Design by Suchman (1967, p. 95). Let X represent the time-telling instruction and O the test results:

O_1 X O_2
O_3 O_4 (Suchman, 1967, p. 95)

Following is a modification of the above design as used in this study. Let X represent the treatment, O the test results, and I the interviews. The subscripts represent the grade level and the test. The subscript "K1" means kindergarten pretest, "32" means third grade posttest, "23" means second grade retention test.

O_{K1}	X	O_{K2}		O_{K3}
O_{11}	X	O_{12}		O_{13}
O_{21}	X	O_{22}		O_{23}
O_{31}	X	O_{32}	I *	O_{33}
O_{K1}		O_{K2}		
O_{11}		O_{12}		
O_{21}		O_{22}		
O_{31}		O_{32}		

*Experimental Group children interviewed were dropped from

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the retention testing to avoid testing any interaction effect of the interviews on the retention test results.

This evaluative research design involves "setting up two equivalent groups which are as alike as possible before the program is put into effect. Such equivalence is best obtained by random assignment to experimental and control groups. Where this is not administratively feasible, one may have to resort to selective matching. Then, a 'before' measure is made to determine the baseline from which change is to be evaluated, and for providing a check on the equivalence of the two groups. One of the groups (experimental group) is exposed to the program being evaluated while the other (the control group) is not, care being taken to keep the groups from coming into contact with each other. At the conclusion of the program (or at appropriate time intervals), an 'after' measure is made with the 'before' measure for both experimental and control groups to indicate the changes produced by the experimental program" (Suchman, 1967, p. 95).

Methodology

The students involved in this investigation were 382 kindergarten through grade three children enrolled in twenty classes in two central New York elementary schools. They had been heterogeneously grouped by the school administrators and the groups were found to be equivalent in I.Q., achievement on standardized

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tests, scores on time telling pretest and chronological age. There were two experimental groups (those receiving the time telling program) and three control groups (no time telling instruction during the investigation) at each grade level (K, 1, 2, 3).

Experimental Group teachers were selected on three criteria as suggested by Brownell (1964, pp. 15-16) in order to provide optimum conditions for cognitive acceleration since many mathematical concepts are imbedded in telling time to the minute. Matching experimental teachers, who were experienced, had displayed competency in teaching arithmetic topics, and who would precisely follow the lesson plans served as a limited control on those teacher characteristics which could influence the data obtained. A similar procedure for the selection of teachers was discussed by Glaser, Reynolds and Fullick:

> In all of the studies, the teacher participated, to a greater or lesser degree, in instruction in the subject matter area involved in the program. As a result, teacher characteristics could influence the data obtained. However, since intact classes were used, teacher characteristics were controlled to the extent that at least two different teachers were involved in each of the experimental conditions. This limited control from dependence upon a single teacher. In addition, all teachers participating in the various studies were chosen on the basis of a positive (or at least a non-negative) interest in trying out programmed instructional materials" (Glasser, Reynolds, and Fullick, 1966, p. 11).

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Data Collected

Group administered paper and pencil tests and interviews with individual children comprised the data collected.

Pretest, Posttest, Retention Test

Three equivalent tests each containing twelve printed clock-faces comprised the pretest, posttest and retention test. Form to form equivalence in regard to content, item placement, distractor placement and position of correct response was maintained. Kuder - Richardson #20 reliability measures of .76 and .79 were established in a pilot study. The pilot study students attended the comparison school but were not involved in the investigation.

The pretest, posttest and retention test were considered "obviously valid" as defined by Rulon:

> . . . What we need is to be able to choose between available test techniques on the basis of what operations we are trying to teach the learner to perform, and what materials we are trying to teach him to perform these operations upon. Both these materials and these operations should be presented in the test situations if the test is to be 'obviously valid.' Such a test must be the criterion by which any not obviously valid test is validated. The 'obviously valid' test is its own criterion (1946, pp. 290-296).

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In addition to the high correspondence between the instructional objectives and the test items, the items were evaluated by subject-matter specialists.[3] They concurred that the tests possessed content validity.

There were five different tasks or behavioral objectives upon which these tests were built:

1. To identify time on the hour.
2. To identify time on the half-hour.
3. To identify time 15 minutes after the hour.
4. To identify time 45 minutes after the hour.
5. To identify time on the minute.

Table 1 lists the types of errors built into the distractors and presents an example of each.

(Insert Table 1 About Here)

Table 2 is a Table of Specifications showing the equivalence of the three tests, item by item. Listed are the content objectives and the type of error committed when selecting the indicated distractor[4] on the Pretest, Posttest and Retention Test.

(Insert Table 2 About Here)

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To avoid biases which sometime occur in favor of a particular response position, the correct answer appeared about equally often in each of the response positions (see Cronbach, 1967, p. 189).

Table 3 shows the position of the correct response for each item on each of the tests.

(Insert Table 3 About Here)

Although, the number of items per test may be considered small, skill in identifying time to the minute is such that children either can perform the behavior or they cannot. The factor of fatigue was also considered in deciding to limit the number of items to 12. A longer test would have been inappropriate for the kindergarten and first graders since all of their written work is short in length and simple in format. The same tests were given to all grade levels in order to preserve an identical base for comparisons across grade levels.

The Pretest and Posttest were administered to both the experimental and comparison groups ten days apart. During these ten days the experimental teachers taught the lesson plans to their classes. The control teachers refrained from teaching time-telling. The Retention Test was administered to the experimental groups six weeks after the Posttest. They received no further time-telling instruction during the retention period.

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Entering Behaviors Test

A minimum set of skills which in the judgment of the investigator was prerequisite to identifying time on a clockface served as the guide for constructing the Entering Behaviors Test. These skills were:

1. Large and small form discrimination.
2. Discrimination of pointer directions: up-down.
3. Distinguishing and naming the directions forward and backward on a clockface.
4. Performing movement in a given direction: up and down, forward - backward.
5. Identifying, stating, ordering observed rate of change in position by means of faster than, slower than.
6. Following simple verbal directions.

These prerequisites were patterned after a set used by Glaser and Reynolds (1964).

Eighty percent of the class had to correctly answer eighty percent of the test items prior to administering the Pretest and before the time-telling instruction was initiated.

Anxiety Measures

The question of can kindergarten (or first grade, or second grade...) children learn to tell time to the precision of a minute was the primary purpose of this investigation. However, the question of should kindergarten (or first grade...) children be

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taught to tell time to the minute was also considered. If the cognition of telling time to the minute was successfully accelerated to the kindergarten or first grade level, but the children displayed a marked increase in anxiousness and nervousness, the evaluation of results would be affected.

The General Anxiety Scale for Children (GASC) was administered to all children in the study and comparisons of range and median scores were made between Experimental and Control groups for the GASC Pretest and the Posttest. In addition, comparisons were made across grade levels within groups.

In order to ascertain whether there was a relation between a measure of "teacher anxiety level" and "her class anxiety level", teachers were administered a pretest and posttest of the abbreviated form of the Taylor Manifest Anxiety Scale (Taylor, 1953). A teacher's scores on the TMAS were compared with her class scores on the GASC.

The Interviews

Approximately 13 percent or 52 of the subjects were randomly selected for interview tasks. Each interview was video taped so that patterns of behavior indicative of high anxiety (excessive wriggling, facial contortions, peculiar nervous habits) could be observed.

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> "The purpose of the interviews was to broaden the base for evaluation by adding criteria, unavailable through group tests, to the traditional criteria of accuracy of work" (Brownell and Moser, 1949, p. 35).

Interview Tasks:

1. The children were asked to reproduce the following times on a clockface: 8:00, 9:30, 2:15, 4:09, 7:22, 3:49, in that order. The following language was used: "Make the clockface show 8 o'clock". "Make the clockface show thirty minutes after 9 o'clock".[5]

2. The children were then asked to identify these times[6]: 2:00, 4:30, 1:15, 3:08, 8:48, 12:24

3. The third task investigated the effect of time telling instruction on the child's conceptual development of the relations of time, speed and distance as described by Piaget (1955, pp. 34-44).

Piaget has pointed out that prerequisite to the concept of time measurement is the awareness that two objects may move at different speeds and traverse unequal distances during the same time duration. This is exactly what the minute and hour hands on a clockface do. The minute hand moves at a speed which is twelve times the speed of the hour hand during an hour's duration. Piaget believes that unless the child can coordinate the time of one movement with the time of another movement he does not possess a real understanding of the structure of time and he has concluded that this does not occur until the child is about eight years old.

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Two identical toy cars were moved by the investigators to comply with the following conditions suggested by Piaget (1955):

a. Same starting point, same speed, same stop point, same time duration.

b. Same starting point, different speed, different stop point, same time duration.

c. Same starting point, same speed, different stop point, different time duration.

Then two larger toy cars that made noise were moved in the same way. Car Task 2 was the crucial relationship so far as time measurement is concerned. Table 4 describes these tasks.

(Insert Table 4 About Here)

Rate of Acceleration

The rate of cognitive acceleration depended upon the student's performance on lesson worksheets and tests. The teacher did not go on to the next lesson until eighty percent of her class correctly answered eighty percent of the test items.

Figure 1 shows the number of lessons completed by each experimental class. Completion of Group 2 Lesson 4 was sufficient for attaining criterion performance on the paper-pencil tests and the interview tasks.

(Insert Figure 1 About Here)

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Treatment of Data

The decision to select teachers according to a set of criteria as mentioned above and the fact that they were to teach their own classes precluded a statistical treatment of the data based on a random selection technique. Descriptive statistics were therefore employed.

The reliabilities in mean score differences between Pretest, Posttest and Retention Test, and in differences in percentages of children reaching a criterion performance level were treated in a matter described by Brownell (1949, 1964). He set a minimum of ten points difference as the requirement for "educational significance." To determine whether the difference in mean scores was educationally significant, Brownell divided this difference by the number of items on the test. If this quotient was ten or more, the difference in mean scores was said to be reliable to the degree of being educationally significant.

In determining whether the difference in percentages of children was educationally significant, he merely subtracted one percentage from the other. Once again the ten point minimum was necessary for the differences to be considered educationally significant.[7]

Brownell's procedure (Brownell, 1949, p. 79) for determining the educational significance of differences between means and between percentages of children attaining a criterion score served

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to enhance the reliability of the descriptive statistics used. It also helped to answer "impact-cost" questions such as, "Did the anxiety measures of children exposed to the acceleration program increase?" "Did the anxiety measures of Experimental Group teachers increase?" "Was the time taken to reach criterion performance level worth presenting the program at kindergarten? At grade 1?" "Did the retention of the skill make it worth teaching the program at K, at grade 1?"

Results

Results of Tests

The Means, Standard Deviations, and Standard Errors of Measurement on the Pretest, Posttest and Retention Test are shown in Table 5 for the Experimental Groups.

(Insert Table 5 About Here)

Table 6 shows the Means, SD's and SE's on the Pretest and Posttest for the Control Groups.

(Insert Table 6 About Here)

Tables 7 and 8 show the increases in mean scores from Pretest to Posttest for the experimental and comparison groups. For the experimental groups, the only educationally significant increase occurred at Grade 1. Grade 2 and 3 may have hit a ceiling since their mean Pretest scores were already near or at the criterion score of 10.0. There were no significant increases in

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mean score for the comparison groups. In fact there were decreases at grades 1, 2, and 3.

(Insert Tables 7 and 8 About Here)

Tables 9 and 10 show differences in percentages of children attaining the individual criterion performance level (eighty percent of test items correct) for the experimental and comparison groups.

Educationally significant differences in percentages of children attaining criterion occurred at grades 1, 2, and 3 for the experimental groups only.

(Insert Tables 9 and 10 About Here)

There were no educationally significant decreases in either mean scores or in percentages of children attaining a criterion score from Posttest to Retention Test. The Retention Test was given to experimental groups only.

Results of Anxiety Measures

No evidence was found to establish a relationship between the accelerated instructional program and an increase in either teacher anxiety or student anxiety. Table 11 shows that no significant increases in median GASC scores occurred.

(Insert Table 11 About Here)

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Results of Interview Tasks

The percentages of experimental and comparison children who reproduced time on a toy clockface were significantly greater than the percentages of children who identified time at grades 1, 2, and 3. None of the kindergarten children reached the criterion on either task as shown in Table 12.

(Insert Table 12 About Here)

The percentages of children who responded correctly to Piaget's car tasks 1 and 3 but not to car task 2 were significantly greater at all grade levels when noiseless cars were used as snown in Table 13.

(Insert Table 13 About Here)

When noisy cars were used, significant differences in the percentage of correct responses continued to occur at kindergarten, grade one and grade two, but not at grade three. See Table 14.

(Insert Table 14 About Here)

The audio cue appeared to facilitate correct responses to task 2 only at grade 3.

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Conclusions and Recommendations

The conclusions were categorized as Content-Referenced and Norm-Referenced (Glaser, 1964, p. 67) so that progress toward a specified goal could be evaluated as well as a relative ordering of groups (or grade levels) with respect to their test performance. For example, the mean gain score (Pre-Post) for the Experimental Group at grade one was educationally significant, but the mean score on the Posttest for this Experimental Group was below the criterion, namely, the correct identification of eighty percent of the test items. Also, the Group Criterion Performance Level (eighty percent of group attaining at least eighty percent of test items correct) was not reached at grade one. Educational decisions as to the success of the cognitive acceleration accomplished in this time telling study will depend, then, on whether the concerns of the decision-makers are primarily content-referenced or norm-referenced.

Content-Referenced Conclusions

1. It appears that in the present investigation grade three and grade two were too late a grade level to introduce telling time to the minute since at least 60% of the third graders and approximately 50% of the second graders attained criterion performance on the time-telling Pretest.

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2. It appears that a diagnostic time-telling pretest should be given to determine how many students need instruction in telling time to the minute. It seems logical that if at least half of the class can perform the skill to criterion level, the topic should be taught in small groups rather than to the class as a whole. Other organizational approaches might include programmed instruction using a film strip to demonstrate the use of the instructional visual aids which the children would manipulate, or "team learning" whereby a child who has the skill works with one who doesn't while following a prescribed instructional sequence.

3. It appears that teaching telling time to the minute initially is an effective technique. The traditional approach has been learning time on the hour first, then time on the half-hour followed by fifteen after, then multiples of five. Telling time to the minute often appeared as a new and sometimes unrelated topic. This is opposite to the development of rationale counting. Children learn to count by "ones" first not last. The traditional approach also has included teaching "1/2" and "1/4" after the hour. The clockface is sometimes shaded as a pie. The children may fixate on the passive

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concept of "pie pieces" instead of building on the active notion of time flowing continuously.

4. It appears that using the language "after the hour" in the initial stages of time-telling instruction may be an effective approach for reinforcing the irreversible nature of time. Piaget's (1955, page 214) discussion of the spatial and temporal meanings of the words "before" and "after" may be a key to the confusion this language brings to children learning to tell time. Piaget describes how "before" means "ahead of" to children younger than seven or eight years of age.

Norm-Referenced Conclusions

1. It appears that bright first graders can benefit most from this particular two week accelerated time-telling program and can retain the skill after six weeks of no instruction. However, when scores of an average Experimental Class and a Comparison Class closely matched on ability were compared, the findings reflected the Grade One Group results. That is, the Experimental Posttest mean score showed a gain and the Comparison Posttest mean score decreased. This implies that average first

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graders can also benefit from this time-telling instruction, but perhaps at a slower rate of presentation.

2. It appears that reproducing time on a toy clockface should precede identifying time since more children in both the Experimental and the Comparison Groups could reproduce time than identify time. It appeared from the findings in this study using this technique of teaching that identifying time is more dependent upon time-telling instruction. Thus, reproducing time may be the more natural activity for young children.

3. Piaget has presented abundant clinical evidence that the concept of conservation of speed is a prerequisite to understanding time measurement. He found that it is not until the age of seven or eight that children understand that the speed of the minute hand does not change in relationship to the child's movement. Another prerequisite for understanding the system of time measurement is the ability to order events. This concept was tested in Piaget's car task two and for the most part, the performance was poor. This implies that instruction in identifying the correct time on a clockface, although it embodies many numerical and spatial concepts, is itself a skill. Thus, it may be premature and inappropriate

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from a learning theory approach to include instruction in measuring time before third grade or seven to eight years of age. However, most traditional programs include items dealing with various times of the day such as, "What time do you get up?" or "What time do you have lunch?" A child may be able to give a stereotype reply, yet not have any idea of the time concept involved.

4. A percentage of children responding correctly to Large Car Task Two at second and third grades are nineteen and forty-three percent greater respectively than the second and third grade performance on Small Car Task Two. These findings seem to provide evidence for the effectiveness of multi-sensori stimulation in accelerating the transition to successful performance on a task involving the concept of temporal ordering. The retention of this transition to successful performance, which was not tested in this investigation because of "time" pressures, should be observed in future research.

5. The results of the anxiety measures for both the children and the teachers offered evidence that neither the faculty nor students involved in the accelerated program suffered from an increase in inhibiting anxiety.

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6. An educationally significant percentage of children who learned to identify time to the minute retained the ability to do so after six weeks of no classroom instruction.

Summary

It has been shown that a re-evaluation is in order of the present age-grade placement of the skill of telling time to the minute. At grades two and three, this skill had already been acquired to satisfy an educationally accepted criterion. The greatest number of children who benefited from the acceleration program occurred at grade one. It appears that a more appropriate presentation of telling time to the minute would be in small instructional groups for those children who do not as yet have the skill, rather than to the class as a whole at grades two and three.

It was found that active involvement in manipulating the clockface hands to show time (reproduce) correctly is an easier task than to read (identify) time correctly when someone else has set the clock.

The findings reaffirm Piaget's theory that conservation of speed is a prerequisite notion to understanding time relations.

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Footnotes

This paper is based on a dissertation submitted by the author to Syracuse University in partial fulfillment of the requirements for the degree of Doctor of Philosophy in mathematics education. Author's address: Division of Elementary Education, University of Georgia, Athens, Georgia 30601. Many thanks to James Wilson, Chairman of Mathematics Education, University of Georgia, for his suggestions on the original manuscript for this article.

1 Cognitive acceleration refers to children learning a topic at an age earlier than usual and at a faster rate than usual. This presupposes academic acceleration, defined here as the moving of a topic normally found at a specific grade level to at least one grade level below the traditional. Academic acceleration is a manipulation of the curriculum which results from cognitive acceleration.

2 A hierarchy of fifty-four behavioral objectives resulted from the task analysis and served as the structure for the time-telling program. See Reisman, Appendix D for lesson plans and objectives.

3 Dr. Vincent J. Glennon, Director of Elementary and Secondary Mathematics Education, University of Connecticut, and Dr. John W. Wilson, Associate Professor of Mathematics Education, University of South Florida.

4 Below each clockface there are three alternatives from which to select the correct time shown on the clockface. Consider the sequence of clockfaces in a horizontal direction, that is, clockfaces 1, 2 and 3 form the top row, clockfaces 4, 5 and 6 form the second row, etc. The possible answers were labeled by their positions: (a) left, (b) middle, (c) right. Thus, an entry such as "2b" in the cell formed by "Time on Hour" and "Reversal - Type A", means that the clockface

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showed a time on the hour, and the middle alternative was an error of Reversal - Type A as described above in Table 1. For example, item number two on the pretest showed 4:00. The alternatives were:

a	b	c
4:00	12:20	5:00

. The alternative "b" on item two was a reversal error which involved an interchange of the minute hand with the hour hand.

5 The language "_____ minutes after the hour" was used for each time except time on the hour where the form "_____ o'clock" was used.

6 Six toy clockfaces had been set to show these times. They were placed on a chair next to the investigator but out of sight of the child and were presented one at a time. If a child failed to correctly identify two in a row, he was requested to reproduce the first one missed to see if he could reproduce but not identify time shown on a clockface.

7 Suchman discusses a concept similar to Brownell's "educational significance". Suchman calls this "program significance of evaluative research". He distinguishes it from "statistical significance of nonevaluative research":

> In nonevaluative research, an independent variable is deemed to have a significant relationship to the dependent variable if the size of the observed association surpasses what might have been expected by chance alone. This is statistical significance. In evaluative research, an independent variable is interpreted as having a significant effect upon the dependent variable if the observed change is judged administratively desirable. This is program significance. Statistical significance relates only to sampling error while program significance (or in this case, educational significance) is usually determined by an input-output relation of impact relative to cost (Suchman, 1967, p. 114).

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Table 1
Examples of Types of Errors Used
As Distractors

Error Type	Example	
	Time Shown	Time Selected
1. Reversal--		
A. Interchanges minute hand with hour hand.	5:00	12:25
B. Interchanges positions dealing with quarter after hour with quarter before hour.	11:45	12:15
2. Names future hour.	2:30	3:30
3. Names previous hour.	8:15	7:15
4. Names Minute incorrectly.	4:19	4:20

Table 2

Table of Specifications For Pretest

Posttest, Retention Test

	Tasks														
	Time on Hour			Time on ½ Hour			15 Minutes After			15 Minutes Before			Time on Minute		
	Pre	Post	Ret	Pre	Post	Ret	Pre	Post	Ret	Pre	Post	Ret	Pre	Post	Ret
Reversal-Type A	2b	2b	2b				5b	5b	5b	6b	6b	6b	7c	7c	7c
	8b	8b	8b							10c	10c	10c	11b	11b	11b
													12c	12c	12c
Reversal-Type B										6a	6a	6a			
Names	1b	1b	1b	3b	3b	3b							12a	12a	12a
Future	2b	2c	2c	4c	4c	4c									
Hour	8c	8c	8c												
Names	1a	1a	1a	3a	3a	4a	5c	5c	5c				7b	7b	7b
Previous				4a	4a	4a									
Hour															
Names										10a	10a	10a	9a	9a	9a
Minute													9c	9c	9c
Incorrectly													11a	11a	11a

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Table 3

Position of Correct Response For Each Item

Tests	Items 1	2	3	4	5	6	7	8	9	10	11	12
Pre	c	a	c	b	a	c	a	a	b	b	c	c
Post	a	b	a	c	b	a	b	b	c	c	a	c
Ret	b	c	b	a	c	b	c	c	a	a	b	a

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TABLE 4

Conditions of Piagetian Car Tasks with Regard to Velocity, Time, and Distance

Task	Speed	Time	Distance
1	Same	Same	Same distance from start
2	Different	Same	Different distances from start
3	Same	Different	Different distances from start

Note. - Following is a pictorial presentation of task conditions.

Task 1

x - - - x

x - - - x

Task 2

x - - - x

x ——— x

Task 3

x - - - x

x - - - - - x

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Table 5

Pretest, Posttest, Retention Test Data--

Experimental Groups

Grade	Pretest			Posttest			Retention Test		
	Mean	S.D.	S.E.	Mean	S.D.	S.E.	Mean	S.D.	S.E.
K(N=33)	5.3	2.0	1.5	6.3	2.0	1.4	6.6	1.9	1.4
1(N=28)	6.8	1.8	1.4	8.5	2.1	1.3	8.4	2.0	1.3
2(N=28)	9.5	1.6	1.2	10.1	1.7	1.3	10.5	1.6	1.3
3(N=44)	10.3	1.4	1.1	10.3	1.2	.9	10.7	1.4	1.0

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Table 6

Pretest, Posttest Data--Comparison Groups

	Pretest			Posttest		
	Mean	S.D.	S.E.	Mean	S.D.	S.E.
K(N=55)	4.8	2.2	1.5	5.1	1.9	1.5
1(N=59)	6.6	1.5	1.4	6.2	1.7	1.4
2(N=58)	9.4	1.8	1.1	9.2	1.9	1.2
3(N=69)	9.9	1.4	1.1	9.6	1.5	1.1

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TABLE 7

Experimental Groups: Increase in Mean Scores from Pretest to Posttest

Grade	Pretest	Posttest	Percent of difference in accuracy
K (N=33)	5.3	6.3	.08
1 (N=28)	6.8	8.5	.14
2 (N=38)	9.5	10.1	.05
3 (N=44)	10.3	10.3	.00

Note. - Educational significance demands a difference in accuracy of at least ten percent.

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TABLE 8

Comparison Groups: Increase in Mean Scores from Pretest to Posttest

Grade	Pretest	Posttest	Percent of Difference in Accuracy
K (N=55)	4.8	5.1	.03
1 (N=59)	6.6	6.2	-.03[a]
2 (N=58)	9.4	9.2	-.02
3 (N=68)	9.9	9.6	-.03

[a] Negative values indicate a decrease in mean scores on the Posttest.

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TABLE 9

Differences in Percentages of Children in Experimental Groups Attaining Individual Criterion Performance Level on the Pretest and Posttest

Grade	Percentage Pretest	Percentage Posttest	Difference in percentage (Post minus Pretest)
K (N=33)	.00	.00	.00
1 (N=28)	.07	.36	.29
2 (N=38)	.47	.82	.35
3 (N=44)	.73	.89	.16

Note. - A minimum difference of ten percentage points is necessary for Educational Significance.

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TABLE 10

Differences in Percentages of Children in Comparison Groups Attaining Individual Criterion Performance Level on the Pretest and Posttest

Grade	Percentage Pretest	Percentage Posttest	Difference in percentage (Post minus Pretest)
K (N=55)	.00	.00	.00
1 (N=59)	.00	.05	.05
2 (N=58)	.53	.60	.07
3 (N=68)	.62	.69	.07

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TABLE 11

Differences in Percentages[a] Between
Median Anxiety Scores on the
GASC Pretest and Posttest

	Comparison			Experimental		
Grade	Pretest	Posttest	Post-Pre	Pretest	Posttest	Post-Pre
K	22	29	.16	24	26	.05
1	19	13	-.07*	17	21	.09
2	24	19	-.11	23	22	-.02
3	27	17	-.22	24	22	-.05

[a] Difference in percentage = Posttest minus Pretest score divided by number of items (45).

* Negative values indicate that Posttest score was less than Pretest score. (Sarason, the test's author, noted that post-test scores are often lower where anxiety has not been increased.)

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TABLE 12

Differences Between Percentages of Children Who Have Attained Individual Criterion Performance Level[a] on Reproducing and on Identifying Tasks

Grade	Group	Percentage Reaching Individual Criterion Performance Level		Differences in Percentage (Reproduce-Identify)
		Reproducing	Identifying	
K(N=0)	Comparison	.00	.00	.00
K(N=7)	Experimental	.00	.00	.00
1(N=5)	Comparison	.20	.00	.20
1(N=8)	Experimental	.25	.13	.12
2(N=3)	Comparison	.33	.00	.33
2(N=14)	Experimental	.57	.36	.21
3(N=3)	Comparison	.00	.00	.00
3(N=5)	Experimental	1.00	.80	.20
K(N=16)	Comp. + Exp.	.00	.00	.00
1(N=13)	Comp. + Exp.	.23	.08	.15
2(N=17)	Comp. + Exp.	.53	.30	.23
3(N=7)	Comp. + Exp.	.70	.57	.13

[a]Individual Criterion Performance Level on the six Reproducing tasks is getting at least five correct. This applies to the six Identifying tasks also.

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TABLE 13

Percentages of Children Responding

Correctly to Piaget's Car Tasks

Grade	Group	Percentages of Children Correct					
		Small Cars			Large Cars		
		Task 1	Task 3	Task 2	Task 1	Task 3	Task 2
K(N=9)	Comp	.79	.44	.11	.89	.44	.22
K(N=7)	Exp	1.00	.86	.14	1.00	1.00	.22
1(N=5)	Comp	1.00	1.00	.20	1.00	1.00	.80
1(N=8)	Exp	.88	.88	.13	.88	.88	.38
2(N=3)	Comp	1.00	1.00	.33	.67	.67	.67
2(N=14)	Exp	.93	.93	.43	.93	.93	.57
3(N=2)	Comp	1.00	1.00	.50	.50	.50	.50
3(N=5)	Exp	1.00	.80	.40	1.00	1.00	1.00
K(N=16)	Comp+Exp	.88	.63	.13	.94	.69	.25
1(N=13)	Comp+Exp	.92	.92	.15	.92	.92	.54
2(N=17)	Comp+Exp	.94	.94	.41	.88	.88	.60
3(N=7)	Comp+Exp	1.00	.86	.43	.86	.86	.86

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TABLE 14

Differences in Percentages of Accuracy

Between Car Tasks One and Two and

Between Car Tasks Three and Two[a]

Grade	Group	Differences in Percentages			
		Small Cars		Large Cars	
		Between 1 and 2	Between 3 and 2	Between 1 and 2	Between 3 and 2
K	Comp	.68	.33	.67	.22
K	Exp	.86	.72	.78	.78
1	Comp	.80	.80	.20	.20
1	Exp	.75	.75	.50	.50
2	Comp	.67	.67	.00	.00
2	Exp	.50	.50	.36	.36
3	Comp	.50	.50	.00	.00
3	Exp	.60	.40	.00	.00
K	Comp+Exp	.75	.50	.69	.44
1	Comp+Exp	.77	.77	.38	.38
2	Comp+Exp	.53	.53	.28	.28
3	Comp+Exp	.57	.43	.00	.00

[a] The differences in percentages were found by subtracting the percentage of Task 2 from the percentage of Task 1 and from Task 3.

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Figure Caption

Fig. 1 - Number of lessons completed by each Experimental class.

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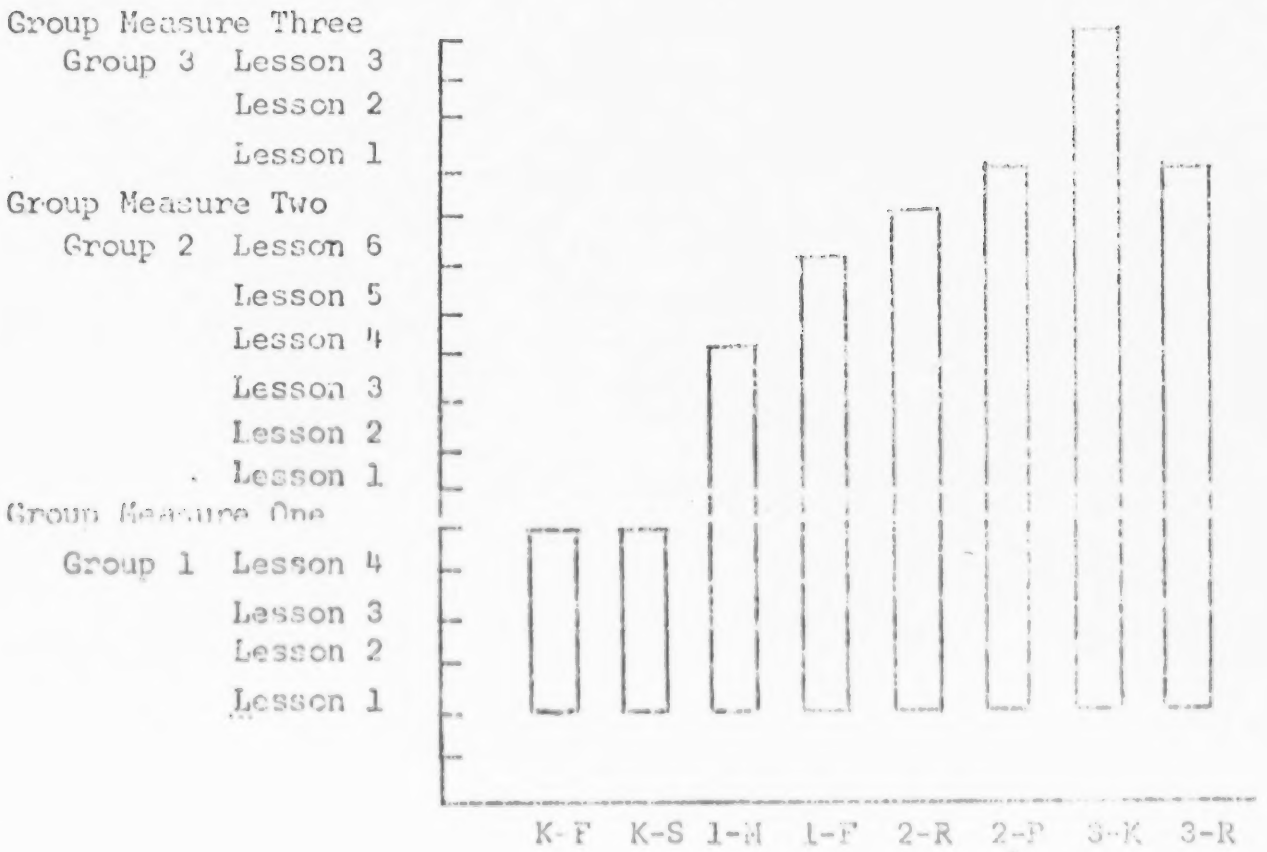

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CURRICULUM DECISION : LEARNING TIME CONCEPTS AND SKILLS

The rationale for this presentation stemmed from pressures calling for academic acceleration which led to radical changes in the elementary school mathematics program. These changes involved incorporating into the lower grades mathematics concepts that had previously been considered appropriate for older children. Examples of these topics are the use of set language in kindergarten, the construction of geometric figures in second grade, and the graphing of coordinate points on a grid. Academic acceleration has been defined as "the moving of a topic (or a skill or concept) normally taught at a specific grade level to at least one grade level below the traditional; it is to be considered a manipulation of the curriculum" (Reisman,1968). This activity has been called by Jean Piaget (Jennings, 1967) "the great American question" when he referred to the hysteria of some American educators of the sixties who focused on how much earlier they could teach concepts and skills that were then being taught at a higher grade level. On the other hand Jerome Bruner made a case for academic acceleration when he implied that "you can teach anything to any child at any age in some intellectually honest form" (1966). This statement was accepted by many educators and textbook publishers with the same vigor as was Euclid's postulate on parallelism; but just as the

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concept of non-Euclidian space emerged, so did the need to test Bruner's hypothesis. The research upon which this presentation is based was an early attempt to study the feasibility of such acceleration. As ideas crystalized during the planning stages of the investigation, it became apparent that the heart of the issue was not academic acceleration but rather cognitive acceleration. Cognitive acceleration was defined as "a child learning a topic at an age earlier than usual and at a faster rate than usual" (Reisman,1968). Academic acceleration is dependent upon cognitive acceleration, the success to which children can learn a specific protion of curriculum at an age earlier than usual. Academic acceleration, then, relies on the degree of cognitive acceleration domonstrated by the child.

How is the rate of learning a phase of cognitive acceleration? If more curricula is to be assimilated at an earlier age, the the rate of learning must necessarily increase to accomodate the increase in amount to be learned. The proponents of academic acceleration, although mentioning the need to make room for more curricula at the earlier grades, did not suggest that very many concepts or skills could be eliminated from these grades and therefore leave us with the alternative of increasing the learning rate.

Learning to tell time to the precision of a minute, usually taught at the end of second grade or in third grade, was the

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portion of elementary school curriculum presented to children in kindergarten, first, second, and third grades for the purposes of this investigation. The study focused on three aspects of the measurement of time. Two of these involved skills and the third idea involved a concept:

Skills

Reproducing time on a clockface

Identifying time on a clockface

Concept

Relation of time and speed with distance

The time telling research was founded on the ideas of three psychologists; Robert Gagne, Jean Piaget, and Jerome Bruner. Gagne's notion of "necessary prerequisits" or a step ladder approach to presenting learning tasks was an important aid in formulating the behavioral objectives upon which the time telling program was built.[1] He has written:

> A person is more likely to be able to learn a new behavior if he has already demonstrated competency in certain behaviors which are subordinate and prerequisite to the new behavior to be learned (Gagne, 1965).

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[1]The fifty-four behavioral objectives and the time-telling program of instruction are contained in the dissertation and may be obtained from University Microfilms, Xerox, Ann Arbor, Michigan. (order no. 69-8648).

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In other words, learning is like a ladder - you need to perform prerequisite behaviors first, step by step. These prerequisite behaviors, however, must first be identified and ordered. The needs for identification and ordering behaviors led to the emergence of two separate analyses of telling time to the precision of a minute. On the one hand a mathematical anaylsis was undertaken to inspect the task's structure. In addition a psychological analysis, based on Piaget's theory and on Bruner's levels of learning, (enactive, iconic, symbolic) served as a guide for sequencing the hierarchy of behaviors identified in the mathematical analysis. The mere identification of task components is inadequate; appropriate sequencing or ordering of these components must mesh with how children learn.

Results of mathematical analysis. One discrepancy found from the mathematical analysis between traditional time telling instruction and the task's structure involved the premature teaching of telling time by groups of five or fifteens. These concepts are high on the mathematical ladder as compared to other concepts; for example, enumerating by ones. However, the traditional sequence of instruction involved counting by fives and then by fifteens prior to focusing on the minute marks which have a one - to - one correspondence with counting by ones. This one - to - one correspondence is the bedrock of much higher mathematics and should occur early in mathematical instruction rather than last. Grouping by fives and by fifteens involves

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a multiplication idea which is a higher level concept than simply counting by ones. The mathematical analysis also yielded a clue as to why children read 2:20 as "four after two," or perhaps as "two after four." The numerals printed on the clockface serve two purposes; they indicate the hour and at the same time denote so many groups of five minutes after the hour. Thus, the numeral 1 on the clockface indicates one group of five ones. the numeral 2 represents two groups of five, the numeral 3 means three groups of five etc. Children do not intuitively grasp the dual role of the twelve numerals on the clockface. Until multiplication has been taught, it is premature to introduce the clockface numerals as cues for multiples of five. The mathematical analysis yielded the fact that counting to sixty by ones was the basic segment of elementary school mathematics curriculum necessary for telling time to the precision of a minute. The concept of multiples of five and its accompanying use of the clockface numerals to indicate groups of five proved to be shortcuts for identifying time on a clockface. These shortcuts were found to be quite high on the structure of the task behaviors. Thus, in Gagne's terms, the hierarchy of behaviors of traditional time telling instruction was not in proper arrangement. Behaviors dependent upon other behaviors were being called for prematurely; before their necessary prerequisite behaviors were present in the child's repetoire.

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Results of psychological analysis. The psychological analysis undertaken in this investigation offered further evidence that the traditional sequence of instruction was the reverse of how children learn mathematics. Children learn to count by ones first, not last. However, the skill of identifying time on a clockface to the precision of a minute (which is essentially counting by ones) always came last in the sequence of instruction. It seems as though authors writing elementary school mathematics textbooks concluded that telling time to the precision of a minute was the most sophisticated of the time telling behaviors and therefore needed to come last in the sequence of instruction. In fact they arbitrarily placed age-grade limits on introducing telling time to a minute by waiting until third grade to introduce this refinement. When the "acceleration bandwagon" emerged, some texts placed the "time to the minute" instruction at the end of grade two but no effort was made to change the sequence of instruction.

The fact that children learn by manipulating real objects was ignored. Instead of guiding them to reproduce time on a clockface, children were engaged in identifying time on clockfaces usually printed in texts or workbooks. Jerome Bruner labeled three levels of learning, the enactive level which involves active involvement on the child's part where he handles objects or uses some form of motor activity, the iconic level

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which involves imagery exemplified by pictures, and the symbolic level which involves written or spoken symbols. (Bruner, 1966). The psychological analysis showed that this hierarchy of levels of learning was often ignored in time telling instruction as children were usually asked to read the time shown rather than to set a real clockface in the initial stages of instruction. Instead of allowing the child to struggle a little with getting to know the clockface, the procedure was usually to show the child a time on a real or printed clockface and have him read the time, the logic being that if he cannot read time on a clockface, he cannot show it. This contradicts evidence that children learn first at the enactive level, then move on to the use of pictures and finally can work at the symbolic level. Identifying time is a passive activity whereas reproducing time actively involves the learner. Active involvement in manipulating the clockface hands to show time correctly seems an easier task than reading time correctly when someone else has set the clock as indicated in the present investigation. It was found that the percentages of children at grades one, two, and three who reporduced time on a toy clockface were significantly greater than the percentages of children who identified time. In many cases children could not identify a specific time on a toy clockface but were able to reporduce this very same time on the same toy clockface only a few minutes after not being able to identify it. None of the kindergarten children reached criterion performance on either task.

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Another aspect of inappropriate instruction in telling time involves the language "after" the hour and "before" the hour. The flow of time is continuous and irreversible in nature. Implicit in the notion of the passing of time is an irreversibility idea; time continues to flow. Now, how have we been teaching telling time? So long as children are using the language "so many minutes after the hour", they are consistent with the forward flow of time. However, many programs switch to "so many minutes before the hour" very early in the time telling instruction. Such usage as "20 minuest to 4" or "20 minutes before 4" comprises language that reverses thought from time after the hour to time before the hour. The child is forced to reverse his orientation when reading times after thrity minutes past the hour. Not only is this reversal in procedure c onfusing and unnecessary, but in the light of Jean Piaget's work, the child between the ages of five to eight may be biologically unable to reconcile the reversibility of the instructional technique with the irreversibility of the time concept. Piaget has observed the sequential development of conservation in children whereby what the child visually perceives no longer interfers with the logic of the situation. Implicit in the notion of conservation is reversibility, the idea that a condition can be changed and then put back into its original form. Although most elementary school mathematics is dependent upon the reversibility

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idea, this is not the case with reading time from a clockface when you consider the continuous forward motion of the hands of the clock. The main rationale for using the language "before the hour" was so that children would need to count only to thirty. However, when one weighs the confusion of changing the language pattern against waiting until the child can count to sixty, the rewards are greater when the child counts to sixty. Also, with the present exphasis on different names for a number, how is the child to know that eighteen minutes before nine is just another name for forty-two minuets after eight o'clock unless he can count beyond thirty? Piaget states that intuitive thought is irreversible while logical thought is reversible. (Piaget, 1969). This theoretical foundation offers evidence that children who are not yet at the stage of logical thought (who are not conservers), may still be able to perform the skills of reproducing and identifying time on a clockface so long as they are not asked to participate in thinking activities involving reversibility.

Many children were able to identify and reporduce time to the precision of a minute who could not perform Piaget's Car Experiment # 2, described below, which was basic to a conceptual understanding of the measurement of time. It was at this point in the investigation that it became apparent that reproducing and identifying time on a clockface were skills

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while an understanding of the relationship between the movements of the hour hand and the minute hand relied on having the concept of the time - speed - distance relation. Piaget found that the young child does not have a concept of time which is radically independent of speed. The child before the ages of seven or eight depends on the equality of the speeds of two objects moving along the same path in order to judge whether or not these two objects have moved for the same amount of time. Piaget says that "at the same time" has no meaning for the young child unless the situation is such that two objects stayed next to each other throughout the entire trip. This situation is referred to as "Car Task 1" in the present investigation. The child observes two toy cars which are started from the same starting position at the same time, move at the same speed and are stopped at the same end position. They are asked to tell if the cars started at the same time and if they stopped at the same time. Figure 1 shows a pictorial representation of Car Task 1:

(Insert Figure 1 here)

The criterion percentage set for all three of the car tasks was eighty; that is, if eighty percent of the children tested at a particular grade level could respond correctly to the task then the grade level criterion was said to have been achieved. Table 1 shows the percentage of children correctly answering Car Task 1 at grades kindergarten, one, two and three. The groups are further broken into experimental and comparison; the experimental

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FIGURE 1: Piaget's Car Task 1

FIGURE 2: Piaget's Car Task 3

FIGURE 3: Piaget's Car Task 2

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groups comprising those children who had participated in the time telling instructional program and the comparison children not having had this program. It is seen that except for the kindergarten comparison group all children interviewed were well above the eighty percent criterion level of correct performance regardless of whether or not they had been taught this particular time telling program. Also, it did not matter if audio cues were added in the sense that one pair of cars had a friction attachment and they made noise when moved while the other pair of cars were quiet when moved.

(Insert Table 1 Here)

Car Task 3 will be discussed next since most of the children reached criterion performance on this task and no pattern seemed to emerge in regard to whether the children were part of the experimental or the comparison group. This task involved starting two toy cars at the same starting position, and making them go at the same speed, but for different amounts of time. In other words one car stops and the other keeps moving for several more seconds. In this case the end positions are different since one car went for a longer time than the other. Again the children are asked, "Did they start at the same time? Did they stop at the same time?"

(Insert Figure 2 Here)

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TABLE 1

Percentages of Children Responding Correctly to Piaget's Car Task 1

Grade	Group	Percentages of Children Correct Quiet Cars	Noisy Cars
K	Exp (N=7)	1.00	1.00
K	Comp(N=9)	.79	.89
1	Exp(N=8)	.88	.88
1	Comp(N=5)	1.00	1.00
2	Exp(N=14)	.93	.93
2	Comp(N=3)	1.00	.67
3	Exp(N=5)	1.00	1.00
3	Comp(N=2)	1.00	.50
K	Exp + Comp(N=16)	.88	.94
1	Exp + Comp(N=13)	.92	.92
2	Exp + Comp(N=17)	.94	.88
3	Exp + Comp(N=7)	1.00	.86

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Table 2 shows the percentages of children correctly performing Car Task 3 at grades kindergarten, one, two and three for both the experimental and comparison groups. In analyzing the responses of those children who did not answer Car Task 3 correctly it was found that they would not agree that the cars started at the same time and this was the reason for their losing credit. However, these same children did answer Car Task 1 correctly.

(Insert Table 2 Here)

Figure 3 illustrates Car Task 2 which involved starting the two toy cars at the same starting position, having them travel for the same amount of time, but making them move at different speeds, thus ending at different end positions. The child is again asked, "Do they start at the same time? Do they stop at the same time?"

(Insert Figure 3 Here)

Piaget found that movements of different speeds, ending at different points in space but involving the same time do not have meaning for the young child. Yet, Piaget says, this coordination of the time of one movement with the time of another movement presupposes a real understanding of the structure of time. Although the child of five or six admits to Car Task 1, he does not yet conceive of the equality of the same durations of time which notion is imbedded in Car Task 2. The six year old child

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TABLE 2

Percentages of Children Responding Correctly to Piaget's Car Task 3

Grade	Group	Percentages of Children Correct Quiet Cars	Noisy Cars
K	Exp(N=7)	.86	1.00
K	Comp(N=9)	.44	.44
1	Exp(N=8)	.88	.88
1	Comp(N=5)	1.00	1.00
2	Exp(N=14)	.93	.93
2	Comp(N=3)	1.00	.67
3	Exp(N=5)	.80	1.00
3	CompN=2)	1.00	.50
K	Exp + Comp(N=16)	.63	.69
1	Exp + Comp(N=13)	.92	.92
2	Exp + Comp(N=17)	.94	.88
3	Exp + Comp(N=7)	.86	.86

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might reply on Task 2 "one of them moved for a longer time because it traveled further". His focus would be on time and distance. Another focus was found to be on time and speed. There are two distinct stages when the focus is on time and speed. A stage one reply might be "one car goes faster and (consequently) takes more time". This reply depends upon the result; faster is equated with farther and concequently with more time. A typical stage two reply is "that one is faster and (consequently) takes less time". This reply depends upon the process of movement; faster means less time in this case.

Car Task 2 is a key to diagnosing whether the child has the cognitive structure for understanding the measurement of time. According to Piaget, (1954-1955) prior to the ages of four to six nothing is gained by attempting to get this age child to conceptualize how a watch measures time because the small child of four to six does not understand that "the speeds of movement of the hands on a watch are coordinated within a t ime duration". The relationship of the cars in Task 2 with the hands on a watch or clockface might be described by the following comparison:

Minute hand : Faster Car = Hour Hand : Slower Car

Unless the child can ignore the distance component and realize that in Car Task 2 the cars started at the same time and stopped at the same time but were positioned differently because one

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traveled faster than the other, he will not be able to understand that although the minute hand travels all the way around the clockface while the hour hand just moves from one numeral to the next, they are both traveling for the same amount of time.

Piaget has defined two parts of the notion of time. One he calls "succession of events" and the other "duration". Succession of events refers to temporal order; events happen first, second, third.... Duration refers to the interval between separate events what is happening after the cars start and until they stop? According to Piaget "the measurement of time is dependent upon the child's understanding of the relation between these two parts of the notion of time". According to Piaget success on Car Task 2 does not occur before seven or eight years of age. Notice that only at grade three was the grade level criterion surpassed and this occured only with the noisy cars.

(Insert Table 3 Here)

Children between the ages of four to six admitted that the cars started at the same time but only when the speeds were the same did they say that the two cars stopped at the same time. Even the eight year olds had difficulty with Task 2 when they did not have the added aid of an auditory cue. Piaget points out that this is not due to a perceptual error, however, because the child acknowledges that when car B stops, car A no longer moves and vice versa. The child refuses to say, however,

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TABLE 3

Percentages of Children Responding Correctly to Piaget's Car Task 2

Grade	Group	Percentages of Children Correct Quiet Cars	Noisy Cars
K	Exp(N=7)	.14	.22
K	Comp(N=9)	.11	.22
1	Exp(N=8)	.13	.38
1	Comp(N=5)	.20	.80
2	Exp(N=14)	.43	.57
2	Comp(N=3)	.33	.67
3	Exp(N=5)	.40	1.00
3	Comp(N=2)	.50	.50
K	Exp + Comp(N=16)	.13	.25
1	Exp + Comp(N=13)	.15	.54
2	Exp + Comp(N=17)	.41	.60
3	Exp + Comp(N=7)	.43	.86

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that the cars came to rest at the same time "together". Piaget points out that the child thinks car B stopped before car A, because car A is ahead of car B in the spatial sense; or else he thinks car B stopped first, because it is spatially closer to him. This confusion with the term "before" may also account for the difficulty children have when they are taught to identify time on a clockface using the language "so many minutes before the hour".

SUMMARY

Three hundred eighty-two children in grades kindergarten through three were given a pretest and a posttest which consisted of twelve printed clockfaces and they were to identify time to the precision of a minute on these clockfaces. The experimental group children were given an equivalent form of these tests six weeks after the time telling instruction ended. Tables 4, 5 and 6 show these results.

(Insert Tables 4, 5 and 6 Here)

A percent of difference in accuracy of ten points or more was considered educationally significant (Brownell, 1964). It appears that the first graders in this study benefited most from this particular program of instruction. The bright first graders made the greatest gains but there is evidence that average ability first graders can also learn to perform this skill of identifying time but at a pace slower than the two week time limitation of this study.

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TABLE 4

Comparison Groups - Increases in Mean Scores

From Pretest to Posttest

Grade	Pretest	Posttest	Difference (Post minus Pre)	Percent of Difference in Accuracy
K(N=55)	4.8	5.1	.3	.03
1(N=59)	6.6	6.2	-.4*	-.03
2(N=58)	9.4	9.2	-.2	-.02
3(N=68)	9.9	9.6	-.3	-.03

*Negative values indicate a decrease in mean scores on the Posttest.

TABLE 5

Experimental Groups - Increases in Mean Scores

From Pretest to Posttest

Grade	Pretest	Posttest	Difference (Post minus Pre)	Percent of Difference in Accuracy
K	5.3	6.3	1.0	.08
1	6.8	8.5	1.7	.14*
2	9.5	10.1	.6	.05
3	10.3	10.3	0.0	.00

*A percent of difference in accuracy of 10 or more is educationally significant.

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TABLE 6

Experimental Groups - Decreases in Mean Scores

From Posttest to Retention Test

Grade	Posttest	Retention Test	Difference (Retention minus Post)	Percent of Difference in Accuracy
K	6.3	6.6	-.3*	-.03
1	8.5	8.4	.1	.08
2	10.1	10.5	-.4	-.04
3	10.3	10.7	-.4	-.04

*Negative values indicate an increase in mean scores on the Retention Test.

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Grades two and three in this particular population were too late to introduce time telling because at least half of these children were already able to perform the skill. A significant number of second and third graders who could not attain criterion on the Pretest could perform correctly on the Posttest. There were no significant decreases in performance on the Retention Test.

This study offers evidence that a diagnostic time telling pretest should be given to determine how many students need instruction in telling time to the minute. Decisions as to whether instruction in this topic is appropriate for the whole class or for part of the class can then be made.

It appears that it is effective to teach telling time to the minute prior to telling time to grosser measures such as halfafter and quarter-after the hour.

It appears that using only the language "after the hour" in the initial stages of time-telling instruction may avoid the confusion which stems from the child's lack of understanding of the spatial meaning of before and after as opposed to the temporal meaning. "Beofre" means "behind," and "after" means "ahead of" to children younger than seven or eight.

It appears that reproducing a measure of time on a toy clockface is easier than identifying time.

It was evident that children who could perform the skill of identifying time did not necessarily have time concepts which are prerequisite to measuring time.

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